5 Embankment Construction

CHAPTER FIVE: EMBANKMENT CONSTRUCTION

The purpose of this chapter is to teach the technician how to properly inspect embankment construction. The knowledge acquired will enable the technician to implement the skills necessary to insure a good, solid, and lasting embankment which is absolutely necessary for a durable and safe highway. Different classifications of materials encountered, lift requirements, compaction methods, benching, density tests, moisture content, earthwork calculations, and specifications relating to each particular area of embankment of construction will be discussed.

ROCK EMBANKMENT

Rock excavation consists of removing rock which cannot be excavated without blasting. This material includes all boulders or other detached stones each having a volume of 1/2 yd^3 or more.

In a rock fill, the lifts are thick and the voids between the rock chunks are large. Although these voids are filled with fines at the top and sides of the embankment, inside the embankment many large voids remain. If these rock pieces remain intact, deformations are small within the embankment because of the friction and interlocking between pieces.

LIFT REQUIREMENTS

The requirements for a rock embankment are:

1) No large stones are allowed to nest and are distributed over the area to avoid pockets. Voids are filled with small stones.

2) The final two feet of the embankment just below the subgrade elevation is required to be composed of suitable material placed in layers not exceeding 8 in. loose measurement and compacted to the required density.

3) Shale or shale-like materials are not permitted in the upper 2 ft of embankment.

4) Where the depth of an embankment is greater than 5 ft and consists entirely of rock, the rock is deposited in lifts not to exceed the top size of the material being placed, but in no case exceeding 4 ft.

5) Where the depth of an embankment is 5 ft or less, or where the material being placed does not consist entirely of rock, the material is placed in lifts not to exceed the top size of the rock being placed, but in no case exceeding 2 ft.

6) The rock for any particular lift is required to be deposited on and pushed over the end of the lift being constructed. If the voids of the last lift are not closed sufficiently, they are required to be choked with small broken stones or other suitable material and compacted as directed.

7) Where a rock fill is to be placed over a structure, the structure is first covered with 2 to 4 ft of earth or other approved material, and properly compacted before the rock is placed.

8) Shale is not incorporated as rock embankment unless written permission is obtained.

COMPACTION METHODS

When rock is used for embankment construction and has such a large top size as to make the material impractical to perform density tests, such material may be compacted with crawler-tread equipment or with approved vibratory equipment, or both. Each lift is compacted thoroughly by successive passes back and forth with the tread areas overlapping enough on each trip so that all portions are compacted uniformly.

SHALE AND SOFT ROCK EMBANKMENTS

If a rock fill were built of rocks which weathered rapidly in the fill, the rock pieces would become soil, which could in turn fall down into the rock voids. The cumulative result of this would be considerable settlement of the embankment and subsequent slope failure. Shales are a good example of this type of failure, since large pieces may degrade (slake) into soil which squeeze down into the large voids. The net result is that large settlements, and even slope instability, may occur.

LIFT AND COMPACTION REQUIREMENTS

The requirements for lift placement and compaction include:

1) Shale, shale and soft rock mixtures, or soft rock be placed in 8 in. maximum loose lifts.

2) The compaction is required to be done with an approved vibratory tamping-foot roller in conjunction with a static tamping-foot roller. Each tamping foot on the static roller

is required to project from the drum a minimum of 6 in. Each tamping foot on the vibratory roller is required to project from the drum a minimum of 4 in.

3) Shale, shale and soft rock mixtures, or soft rock is required to be compacted to at least 95 percent of maximum dry density.

4) The moisture content is required to be controlled within -2 and +1 percentage points of optimum moisture content.

5) The density is measured with a calibrated nuclear gauge.

6) Water is required to be applied to the shale in the cut to accelerate the slaking action and again prior to disking and compaction. Water is paid for on a volume basis.

7) The water is required to be uniformly incorporated throughout the entire lift by a multiple gang disk with a minimum disk wheel diameter of 24 in.

8) Unless otherwise approved in writing, each embankment lift is required to receive a minimum of three passes with the vibratory roller. A roller pass is defined as being one complete coverage of a given area. The material is required to be bladed before using the vibratory roller.

EMBANKMENTS ON HILLSIDES AND SLOPES

Before an embankment is placed on natural soil slopes or existing fill slopes steeper than 4:1, benches a minimum of 10 feet wide, unless otherwise specified, are cut into the slopes prior to the placement of embankment fill. Before placing embankment on natural soil slopes of 4:1 or flatter, the existing ground surfaces are plowed or deeply scarified.

If benches are cut, the excavation is paid for at the contract unit price per yd^3 for the class or classes of excavation encountered. No direct payment is made for plowing or scarifying.

EMBANKMENT OVER EXISTING ROADS

Whenever constructing an embankment over an existing roadway, certain precautions are required to be taken.

TREATMENT OF EXISTING PAVEMENTS

1) If embankments for new pavement are to be placed over an area where a rigid pavement is in place and the upper surface of the existing pavement is 12 in. below the subgrade elevation of the proposed new pavement, the existing pavement is required to be removed.

2) If embankment for new pavement is to be placed over an area where an existing rigid pavement is in place and the upper surface of the existing pavement is more than 12 in. but less than 3 ft. below the subgrade elevation of the proposed new pavement, the existing pavement is required to be broken. The pavement is broken so that the area of any individual piece does not exceed 1 yd^2.

3) If embankment for new pavement is to be placed over an area where a hot mix asphalt surface on a concrete base is in place, and such existing surface is more than 12 in. but less than 3 ft below the subgrade elevation of the proposed new pavement, the hot mix asphalt is required to be removed and the concrete base is broken.

4) If embankment for new pavement is to be placed over an area where a hot mix asphalt pavement is in place, the top of which is set at the approximate elevation of 12 in. or less above or below the required subgrade elevation of the proposed new pavement, the existing pavement is broken and removed to the depth directed, but no less than 12 in.

5) If embankment for new pavement is to be placed over any existing pavement, the top of which is greater than 3 ft below the required subgrade elevation, the existing pavement is left in place.

6) If an embankment is to be widened, precautions are taken to ensure a firm foundation. After all perishable material has been removed, the existing shoulders are plowed down 2 ft out from the existing pavement. This material is used for widening. Benches, a minimum of 4 ft. wide, are cut into slopes of the old embankment unless otherwise directed. No direct payment is made for plowing or benching, the cost thereof to be included in the various pay items of the contract.

DENSITY CONTROL

The following density control requirements are included in the duties of the grade technician:

1) Unless otherwise specified, all embankments are compacted to at least 95% of their maximum dry density.

2) The moisture content is controlled within -2 and +1 percentage points of optimum moisture content.

3) If the embankment material is too wet, the material is aerated to remove excess moisture.

4) If the embankment material is too dry, the material is watered and disked to increase the moisture content.

5) The embankment material is placed in uniform level layers, and compacted with approved compacting equipment. Compacting equipment is required to include at least a three-wheel roller or other compacting equipment capable of providing a smooth and even surface.

6) Each lift is disked or treated by some other mechanical means which ensure the breaking up of any existing lumps and clods.

7) The loose depth of each lift is required to be such that the required compaction may be obtained, but in no case exceed 8 in.

8) Where a tamping roller is used, the loose depth of lift is required to not exceed the length of the tamper feet. The surface area of the end of each foot of the tamping roller is required to be no less than 5 in^2.

9) When silts, silty loams, or loessial type soils are encountered and used in embankment construction, the moisture content is controlled within -3 percent of optimum and the optimum moisture content.

10) Field compaction tests are required to be conducted on each lift, and the required compaction obtained on each lift before the next lift is placed.

11) The moisture content for sandy soil or a sand and gravel soil, having at least 80% sand and gravel size particles, is required to be such that the soils may be compacted to the specified density, which is normally several percentage points below optimum or as directed.

SETTLEMENT CONTROL

Preliminary investigation has found that the existing soil below the embankment settles over time when a heavy embankment is constructed. Therefore, settlement control is necessary to measure this settlement and to insure that the settlement has slowed to an acceptable rate. This work consists of providing, installing, maintaining, and reading various types of geotechnical instrumentation at locations shown on the plans or as directed as follows:

1) Prior to the beginning of embankment operations in any area, 1/2 in. by 3 ft by 3 ft settlement plates equipped with sections of 3/4 in. and 2 in. galvanized threaded pipe and couplings for a cover are installed at locations as shown in the plans.

2) The 3/4 in. pipe sections for the settlement plates are required to be 4 ft. Such pipe sections may be extended vertically from the center of the plates up through the new embankment as the embankment increases in height. The pipe sections are spot welded at the joints. A cover of pipe of 2 in. is slipped over the pipe and not welded to the plate. The 3/4 in. steel pipe and 2 in. cover extend 2 ft or more above the grade of the new embankment at all times during grading operations and the settlement period.

3) In addition to the settlement plates, lateral stakes are installed, if shown on the plans. The stakes are required to be 3/4 in. by 4 ft. steel rods and are driven to at least 12 in. into the ground.

4) B Borrow is used as embankment material around settlement plates and pipe to protect this equipment during construction.

5) After the embankment has been constructed to subgrade elevation, settlement stakes are installed at the locations as set out in the plans. The stakes are required to be 3/4 in. by 4 ft. steel rods.

6) During the construction of the embankment, elevation readings are taken on all settlement plate extension pipes and settlement stakes at the end of each 7-day period, or more frequently if the conditions warrant.

7) After the embankment has been constructed to subgrade elevation, readings are taken on the settlement stakes, in addition to the settlement plate extension pipes. Lateral stakes are used to monitor horizontal movement of the ground or new fill. If lateral is observed during construction of the fill, the work is suspended and corrective measures are taken as directed.

8) Unless otherwise directed, the new embankment, after being constructed to subgrade elevation, is allowed to settle for a period of 3 months.

9) After the embankment is constructed to the subgrade elevation, a reading is taken every seven days until the settlement rate is ¼ in.or less for four consecutive weeks. The monitoring period may be reduced as directed by the Office of Geotechnical Engineering. If the results of any readings indicate that the new embankment has a settlement greater than ¼ in., the monitoring period is extended until the settlement requirements are met.

10) In the event that serious settlement develops during the construction of the embankment or within the required settlement period, the work is required to be suspended and corrective measures taken as directed.

METHOD OF MEASUREMENT

Pay Item	**Pay Unit Symbol**
Borrow……	cys
Breaking Pavement……	sys
Cased Test Holes……	lft
Embankment……..	cys
Emb. Foundation Soils Treatment…….	sys
Excavation, Common……	cys
Excavation, Peat……	cys
Excavation, Rock……	cys
Excavation, Unclassified……	cys
Excavation, Waterway……	cys
Excavation, Y……	cys
Exploratory Cores……	lft
Exploratory Drilling……	lft

Linear Grading……	sta
Settlement Plate……..	each
Stake, Lateral…….	each
Stake, Settlement…….	each
Water for Shale……	gal